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ANIMAL ANALYSIS

WHIPPLE

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WHIPPLE'S

ANIMAL ANALYSIS;

A

METHOD OF TEACHING ZOOLOGY.

TO WHICH IS ADDED AN

APPENDIX,

CONTAINING

DIRECTIONS FOR FORMING A SCHOOL CABINET.

By ELLIOTT WHIPPLE, M. A.

CHICAGO:
JANSEN, McCLURG & CO.,
1877.

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INTRODUCTION.

A FEW teachers of Zoology, favorably situated, are able to get their pupils to study *animals* instead of *books;* the majority, although theoretically opposed to an almost exclusive use of books, practically find no other way in which to secure regular and constant work from their classes.

For the purpose of obviating this difficulty, the "Analysis of Animals" has been prepared, and it is believed that, if rightly used, it will enable teachers satisfactorily to combine the study of books and the study of nature.

With most pupils the difficulty is, that they do not know how to study or what to observe, and, if they are set at work upon specimens without a guide, they turn them over aimlessly for awhile, and then, discouraged with this profitless proceeding, beg to be allowed to return to the safe and familiar shelter of a text-book.

When the teacher can spend his time with the class during their study hours, stimulating by questions and aiding by suggestions, all this may be changed; but how few can spare time and strength for very much of such work!

The "Analysis of Animals" supplies the questions, shows the pupils what characteristics to look for, and affords convenient means of testing the amount and quality of work done.

The author offers this plan as a step in advance, but as *one* step only, and hopes that his fellow teachers, who may use it, will freely communicate to him objections and difficulties, as well as suggestions for its improvement.

HOW TO USE THE "ANALYSIS."

Beginning in the usual way, the class learns somewhat thoroughly the characteristics of one branch, *e. g.*, vertebrates, noticing the other branches briefly. Then one class, say mammals, is studied, some comparison being made with other classes of the same branch. Then two or three orders with their prominent families, and a few of their genera and species are mastered.

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At this point, by means of a comparative review of the ground passed over, the following KEY may be developed in the minds of the class, but care should be taken that they receive it as a *servant*, to be *used*, and not as a *master*. It is intended as a guide to the pupil in writing out his "analyses," but it is neither infallible nor complete. It should be followed only so far as it appears to be in accordance with nature:

KEY.

Branches are characterized by plan of structure of

1. Nervous system.
2. Skeleton.
3. Blood.
4. Miscellaneous points.

Classes are characterized by execution of plan in respect to—

1. Reproduction.
2. Respiration.
3. Circulation.
4. Epidermis.
5. Details of structure.
6. Miscellaneous points.

Orders are characterized by complication of structure in—

1. Locomotive appendages.
2. Mouth parts.
3. Miscellaneous points.

Families are characterized by general resemblances of—

1. Form.
2. Miscellaneous points.

Genera are characterized by details of structure in special parts, such as—

1. Modifications of organs used in obtaining food.
2. Miscellaneous points.

Species are characterized by—

1. Size.
2. Ornamentation.
3. Proportion of parts.
4. Miscellaneous points.

The key having been written on the black-board with blank spaces to the right, provide a suitable specimen, alive or stuffed—a cat, a dog, or a rat,—and have the members of the class with the aid of the teacher, proceed to fill out the blanks with the appropriate characteristics of the specimen before them. At the next recitation, each pupil may place upon the board an "analysis" for criticism and correction. After the students become somewhat familiar with the work, it will only be necessary for them to bring in their "analyses" for criticism, as would be done with other written exercises

All "analyses" should be made with a specimen of the species to be described, at hand; otherwise the work will degenerate to a servile copying from text-books.

An entertaining and profitable exercise is to have pupils place upon the black-board. or recite orally, "analyses," leaving the names of the branch, class, order, etc., blank, the blanks to be filled by other members of the class.

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If the teacher is sufficiently familiar with the subject, or has time and inclination to study, it is an excellant plan to pursue the same course with the written "analyses" that are to be handed in by the pupils; for if the descriptions are so full and accurate that the teacher can supply the *names* of the branch, class, order, family, genus and species to which the specimen belongs, it affords a very satisfactory *test* of the work, and at the same time this process stimulates both pupils and teacher to an unusual interest in the study.

An interesting occasional exercise is to bring in specimens belonging to groups already studied and call for extempore "analyses."

It is not necessary that all "analyses" should be carried out to the genus and species; the limit will depend upon the time and ability of the class. Some complete "analyses" should be made; some may include only families; and some may stop with orders or sub-orders.

No direct provision has been made for sub-classes and sub-orders, etc., but where such sub-divisions are deemed important they can be introduced, as in sample No. 3.

A good review exercise is to have pupils prepare tables containing brief statements of most important characteristics, arranged in accordance with the key.

Two samples are inserted:

TABLE OF BRANCHES.

PLAN OF STRUCTURE OF.	NERVOUS SYSTEM.	SKELETON.	BLOOD.
VERTEBRATES.	Cerebro—spinal and sympathetic.	Internal Vertebræ with neural and haemal arches forming *two* cavities.	Red.
ARTICULATES.	Double ganglia, arranged in a line.	Rings, surrounding a single cavity.	Usually Pale.
MOLLUSKS.	Ganglia, arranged variously.	Soft bodies, with usually an external shell.	Pale.
RADIATES.	Ganglia in a circle.	Radiating from a vertical axis.	Colorless.
PROTOZOA.	None discovered.	Minute animals, having no common type.	

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TABLE OF THE CLASSES OF VERTEBRATES.

Execution of Plan in Respect to:	Reproduction.	Respiration.	Circulation.	Epidermis.	Details of Structure.
Mammals.	Viviparous, and nourish young with milk.	Lungs.	Heart, with four cavities.	Usually hairy.	Plane Vertebræ.
Birds.	Oviparous.	Lungs and air sacs.	Heart, with four cavities.	Feathered.	Plane vertebræ, anchylosed to a large extent.
Reptiles.	Oviparous, or Ovoviviparous.	Lungs.	Heart with three cavities, usually.	Scaly.	Usually convexo-concave vertebræ.
Batrachians.	Oviparous.	Gills at first—usually lungs are developed in adult forms.	Heart with three cavities, usually.	Smooth.	Usually convexo-concave vertebræ or double concave.
Fishes.	Oviparous or Ovoviviparous.	Gills.	Heart with two cavities.	Scaly or Smooth.	Double concave vertebræ, or concavo-convex.

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Explanatory Remarks.

Experience shows that certain difficulties are especially liable to arise in applying the Key, hence a few suggestions are added.

The fundamental idea is that there exists a parallelism of characteristics in groups of the same name through the whole animal kingdom.

Under each division, except species, is placed a general statement of the nature of the characteristics of that division; *e. g.* branches are characterized by plan of structure, classes by execution of plan, etc.

Under these general statements are placed a number of points indicating where to look for the application of the general statement; *e. g.*, under execution of plan, we find five points of application named; 1, Reproduction; 2, Respiration; 3, Circulation; 4, Epidermis; 5, Details of Structure; which are intended to show five particulars in which proper class characteristics may be found; in all cases the word miscellaneous is added, because in no case is the list of possible characteristics exhausted, and some teachers may prefer to carry out the work to a greater extent than others.

Whenever a student does not know *how* to fill a blank in regard to some particular point, he should leave it unfilled until he can obtain the requisite information; but enough points must always be filled to indicate the name of the group before the work is allowed to pass.

It would seem that the value, or at any rate the application, of the characteristics, changes somewhat in passing from higher to lower groups. In nearly all the orders of vertebrates, we must look for "complication of structure of locomotive appendages," not in the *number* of such appendages, but in some differences in structure and use. Men have hands and feet *unlike;* monkeys, *alike.* Carnivora are armed with sharp claws; ungulata, with hoofs. Cheiroptera have expanded membranes for flying; Cetacea, flippers for swimming. But in most of the lower branches the *number* of locomotive appendages appears to be *their* "complication of structure." Insects have six legs; arachnida, eight; decapods, ten; centipedes, many.

Pupils are often puzzled to know what is meant by the general statement for family characteristics. "General resemblances" are those points that would usually be noticed by untrained observers, enabling them to group together animals having a general similarity of *form;* the shape of the head, shape of body and limbs, anything in their structure modifying their manner of moving, and *not* amounting to a "complication of structure."

Generic characteristics, are those pertaining to particular details in special parts—the *finishing off.* It is suggested in the Key that these details may be found in some

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"modification of the organs used in obtaining food;" but they may occur in any part of the animal.

In describing species, it must be noticed that "size" can be a distinction only for adult forms, but the "proportion of parts," that is the relative length or size of various parts, affords a more general means of discrimination.

In domesticated animals most of the specific characteristics *vary*, and the original characteristics, or those occurring in animals in a state of nature, should be given when known, and the fact of variation stated.

The principles on which the Key is founded have been derived from the writings of Agassiz, especially his "Essay on Classification" and "Methods of Study in Natural History."

In carrying out this plan, students will need access to *some* or *all* of the following books of reference, according to the extent and direction of their studies:

Jordan's Manual of Vertebrates, Tenney's Manual of Zoology, Nicholson's Manual of Zoology, Chamber's Encyclopedia, Orton's Comparative Zoology, Smithsonian Miscellaneous Collections, Coues' Key to N. A. Birds, Packard's Guide to Study of Insects, and various State Entomological reports. A cabinet is important, but not absolutely essential. By following the directions given in the appendix, any zealous teacher can in two seasons form a very good collection.

The ultimate aim should always be to enable students to make out "Analyses," without reference to any book but the great Book of Nature.

WESTFIELD, Ill., October, 1877. E. W.

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Locality .....

BRANCH.	
1. Nervous System.....	.....
2. Skeleton	.....
3. Blood.....	.....
4. Miscellaneous.....	.....
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CLASS.	
1. Reproduction.....	.....
2. Respiration.....	.....
3. Circulation.....	.....
4. Epidermis.....	.....
5. Details of Structure...	.....
6. Miscellaneous.....	.....
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ORDER.	
1. Locomo. Appendages	.....
2. Mouth Parts.....	.....
3. Miscellaneous.....	.....
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FAMILY.	
1. Form.....	.....
2. Miscellaneous.....	.....
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Date..... *No.*.....

GENUS.	
1. Organ used in obtaining food.	.....
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2. Miscellaneous.....	.....
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SPECIES.	
1. Size.....	.....
2. Ornamentation.....	.....
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3. Proportion of parts...	.....
4. Miscellaneous.....	.....
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REMARKS.	
If useful, how?.....	.....
How propagated?.....	.....
If injurious, how?.....	.....
How repressed?.....	.....
Facts in regard to reproduction, migration, distribution, etc.....	.....
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If useful, how?.....	.....
How propagated?.....	.....
If injurious, how?.....	.....
How repressed?.....	.....
Facts in regard to reproduction, migration, distribution, etc.....	.....
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Interesting peculiarities..	.....
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Digitized by Google

Digitized by Google

INDEX.

NAME.	PAGE.

Digitized by Google

INDEX.

NAME.	PAGE.

Digitized by Google

APPENDIX.

DIRECTIONS FOR FORMING A SCHOOL CABINET.

A cabinet is not absolutely essential to a right use of the "Analysis," for there are animals enough about us at all seasons of the year to furnish abundant materials for study, and the *nature* of branch characteristics can be learned from the study of *one* branch as well as *another;* the *nature* of generic characteristics from the study of *one* genus as well as *another*, and so of the other subdivisions in the key; yet, for comparative study, a wide range is desirable, and the earnest teacher can, with the aid of his pupils, easily gather such a collection as will add much to the interest and instructiveness of the school work, as well as be an object of attraction to visitors.

These directions are condensed from the eleventh volume of the Smithsonian Miscellaneous Collections, with modifications suggested by experience, and are intended for those who have had little or no practice.

The Cabinet

may be at first a simple book-case; but soon the school authorities should be induced to construct a tight case, with glass doors above and wooden doors below.

The shelves should be about twelve inches wide, and the same distance apart, alternating with others half as wide, placed half-way between. Some should be horizontal; others, especially the upper ones, inclined.

A portion of the space below should be devoted to insect-drawers made as tight as possible with glass tops, lined at the bottom with cork, or with a frame one-eighth of an inch thick, covered on both sides with paper moistened and glued to the edges of the frame, which should be fastened an eighth of an inch from the bottom of the drawer. Inside depth of drawer, two inches.

The Kinds of Specimens

most needed are small Mammals: foxes, weasels, raccoons, bats, squirrels, rabbits, rats and mice, moles and opossums. Birds: swallows, sparrows, larks, black-birds and jays, humming birds, woodpeckers, hawks, owls, quails, pigeons, herons, plovers and ducks.

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Reptiles: turtles, lizards, common snakes and rattlesnakes. Batrachians: toads, tree-toads, frogs, salamanders, and mud-fish. Fish: sharks, skates, sturgeons, cat-fish, trout, eels, flounders, and the amphioxus. Insects: bees, ants, wasps, butterflies, moths, flies, beetles, cicadas, squashbugs, crickets, locusts or grasshoppers, dragon-flies, centipedes and spiders. Crustaceans: cray-fish, wood-lice and barnacles. Worms: earth-worms, leeches, tape-worms, and hair-worms. Mollusks: snails, slugs and clams. Radiates: sea cucumbers, sea-urchins, and sand-dollars, star-fish, serpent-stars, crinoids, sea-anemonae and corals.

If located on the sea-shore, nearly all these can be gathered by the pupils; if in the interior, the marine specimens can easily be obtained in exchange for fossils or other specimens peculiar to the locality.

The Naturalists' Directory, published by S. E. Cassino, Salem, Mass., gives the address of those desiring to make exchanges.

Mammals can be obtained by setting traps, or placing around their haunts their favorite food, poisoned with strychnine.

In obtaining birds, resort must be had to the use of a shot-gun. Use the finest shot possible.

Wounded birds may be killed by compressing the chest under the wings.

Apply plaster of Paris freely wherever bleeding occurs. Plug nostrils with cotton, and wrap carefully in paper.

The finest moths and butterflies can be obtained in a perfect state only by gathering cocoons from bushes, fences and trees, and securing the imagos when they develop in the spring.

Ask the pupils to take small boxes with them on their walks, and to look under stones and logs, and beneath the bark of decaying wood, and soon you will have enough to do to take care of the specimens that will be brought in. Your schoolroom will make one think of Noah's Ark.

The Killing of Specimens

can be conveniently accomplished by inclosing them in a tight vessel, and pouring in a little naptha.

Naptha or benzine can be purchased at wholesale for about twenty-five cents a gallon.

Most insects and very small animals can be speedily killed by placing them in a two or four ounce vial, having a wide mouth, and containing five cents' worth of cyanide of potassium, covered with a little cotton, above which is glued a circular piece of paste-board.

This preparation, if kept corked, will retain its efficiency for years.

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Preparation of Specimens for Preservation.

The most essential instruments are a sharp knife, a pair of sharp-pointed scissors, a pair of stout scissors or shears, and a needle and thread.

Begin with a small mammal, such as a rat, a mole, or a squirrel.

Provide some plaster of Paris, and apply it freely during the whole process of skinning, so as to absorb all blood and moisture. Corn-meal may be substituted, especially if the flesh is desired for culinary purposes.

Make an incision from the middle of the breast to the anus; separate the skin from the flesh as far as possible in all directions, using the fingers chiefly; extend the incision by cutting round the anus; push the first joint in the hind limbs up through the incision, and sever at the joint; pull the tail out of its skin, or, if this cannot be done, sever from the backbone; separate the skin from the flesh, turning it wrong side out over the head; sever the fore limbs, and continue skinning until the eye-balls are exposed; cut carefully behind the ball so as to sever the nerve and muscles, and remove it by grasping between the thumb and knife-blade; cut the neck from the head, removing a portion of the rear of the skull, so as to expose the base of the brain, which can then be scraped out; remove, as neatly as possible, all the flesh from about the skull, the limbs and the skin.

The skin is now ready for the application of

The Preservative.

Dry arsenic is often used, but arsenical soap is cheaper and more certain to preserve. It can be made by mixing hastily with water:

Carbonate of potash - - -	12 ounces,
Arsenic - - - - - - -	4 "
Air-slacked lime - - -	4 "
White soap - - - - - -	4 "
Powdered camphor - - -	¼ "

Moisten and apply with a small brush to every part of the inside of the skin. The same preparation will do for the skins of all kinds of animals.

Turn the skin right side out, stuff with cotton nearly to original size, sew up the incision, tie the legs in a convenient position, and the specimen is ready for *study*.

Preparing for Exhibition.

If intended for exhibition, after applying the preservative, prepare an artificial body of nearly the size and shape of the animal, by winding thread or twine about excelsior stuffing, fine hay, straw, or dried moss; fasten a wire into the skull, and pass it lengthwise through the prepared body; put a little cotton in the eye sockets, insert the artificial eyes, and turn the skin back over the head; pass wires down the limbs to

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the feet, and wind the limbs with cotton to nearly the original size; continue reversing the skin, fastening the limb wires *firmly* to the body; pass a wire down the tail, and fasten it to the body; fill out with cotton, if any portion is deficient, and sew up the incision; set up the specimen in some natural, life-like position, squeezing and moulding it into shape; fasten limbs, toes, tail, and ears in position, by means of pins and wires; apply an alcoholic solution of strychnine to ears, lips and toes, to ward off insects; and set away to dry in a secure and airy place.

Turtles, lizards, serpents, and fish may be prepared in the same way as mammals. Batrachians usually lose their color and dry up so as to be useless, unless preserved in alcohol.

After practicing awhile on Mammals,

BIRDS

may be undertaken. A blackbird or a blue jay is best to begin with.

The process is nearly the same as for Mammals, except that there is more danger of tearing the skin, and more care is requisite to avoid ruffling the feathers.

When finished, smooth the feathers, apply alcoholic solution of strychnine as to Mammals, tie legs in a position parallel with body, and roll in paper to hold wings in place while drying.

Any one can prepare birds for study; few can mount them for exhibition without instruction from a living teacher. The attempt usually results in ludicrous and disgusting caricatures of these most beautiful and graceful of natural objects.

BIRD'S EGGS

are easily prepared by pricking a small hole in each end and blowing out the contents.

INSECTS

can be kept for some time by simply pinning in a tight drawer, and keeping camphor gum present in abundance; but a better plan is to soak them for twenty-four hours in a solution of alcohol and arsenic, about ten grains to the quart.

For permanent exhibition, soak a month and wash off the white scaly effervescence with alcohol. Another method is to soak two hours in a solution of corrosive sublimate and alcohol, one part to a thousand; this preserves from *mould* as well as *insects*.

Most insects should be pinned exactly through middle of thorax, but coleoptera through right wing-cover.

Very small insects may be gummed to pasteboard or mica, through which the pin may be passed.

In order to dry the wings of insects in a suitable position, it is necessary to have a

SETTING-BOARD.

This can be constructed by placing two narrow strips of board nearly parallel, so

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as to leave a space between them varying in width from three-eighths of an inch at one end to three-fourths of an inch at the other. Incline the strips a little toward the groove thus formed, and nail in this position by means of stout cross-pieces, sawn obliquely toward the center.

The strips should be covered smoothly above with cork, and beveled on the under edges next to the groove. A stout parallel strip a half inch in width, and covered with cork, should be placed just below the groove to receive the pins.

The wings can be fastened in place on the surface of the upper strips by narrow pieces of pasteboard pinned across them. The legs and antennæ can be fastened in any position desired, in a similar manner.

Dried Specimens

can be moistened and relaxed by placing in a box containing a layer of wet sand, covered with a single thickness of soft paper.

To relax skins of larger animals, wet cloth or paper must be placed in contact with the inside of the skin.

The Larvae of Insects

can be preserved permanently, without loss of form and color, in a filtered solution of two and a half pounds of salt and four ounces of nitre in a gallon of water; but first soak in a solution of a quart of the foregoing with two ounces of arseniate of potash in a gallon of water.

Skeletons

should be secured in as great variety as possible. These may be prepared by removing the flesh without disturbing the ligaments at the joints, soaking in water frequently changed until all blood and flesh is removed, and then soaking in a solution of alum and salt, half an ounce of former to half a pound of latter.

Set up by means of wires, in some natural position. If disjointed, holes can be bored into the ends of the bones, and articulations made by means of wires, which is the most satisfactory way, though involving a good deal of labor. Bury bodies near ant-hills, and the ants will clean the bones nicely.

Sets of vertebræ, and other corresponding parts of different classes of animals, are very interesting and instructive, and are easily secured.

Alcoholic Specimens

should be kept for some time in a mixture of alcohol and water, and finally placed in pure alcohol for permanent preservation.

Labels

keep best when written carefully with a lead-pencil. Every specimen should be labeled

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with the locality and date of capture, and anything of interest which it may be desirable to remember.

If designed for *exhibition* rather than *study*, put on the name, both scientific and common; also the name of the *donor*.

NATURALISTS' SUPPLIES,

such as eyes (black or colored), pins, cork, tools, etc., can be obtained at the Naturalists' Agency, S. E. Cassino, Salem, Mass.; also of A. E. Foote, 1223 Belmont Avenue, Philadelphia, Pa. The spherical black glass beads sometimes worn in necklaces, afford a very good and cheap substitute for artificial eyes.

Make the most of every specimen; do not take the life of any sentient being unnecessarily, and always with as little pain as possible.

Reverence the handiwork of the Creator in the least of His creatures.

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